

[54] **GEAR WHEEL PUMP WITH FEED
PASSAGE OF CONSTANT HYDRAULIC
CROSS SECTION**

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Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 40,279, May 25,
1970, abandoned.

[52] U.S. Cl. **418/206**

[51] Int. Cl. **F01c 1/18, F03c 3/00, F04c 1/08**

[58] Field of Search..... **418/205, 206**

[56] **References Cited**

UNITED STATES PATENTS

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[57] **ABSTRACT**

Gear wheel pumps, in particular melt pumps for ves-
sels at subatmospheric pressure, whose pump casing
consists of three plates stacked tightly against one an-
other, the middle plate having two contiguous, par-
tially overlapping housing intermeshing gear wheels,
one gear wheel being driven. The middle plate con-
tains a feed passage of constant hydraulic cross sec-
tion and a discharge passage for the liquid to be
pumped via pipes or tubes connected therewith.

3 Claims, 4 Drawing Figures

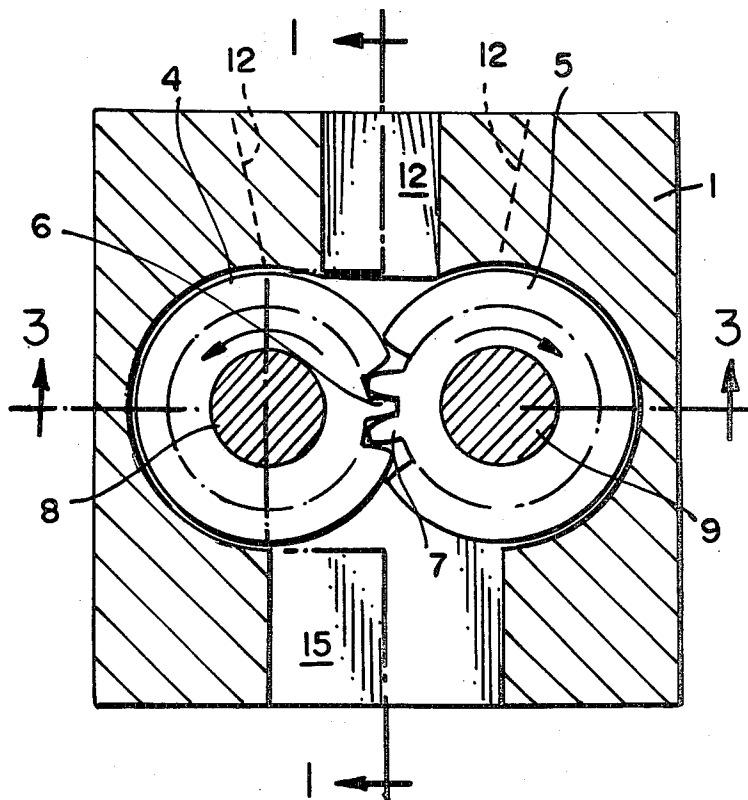


FIG. 1

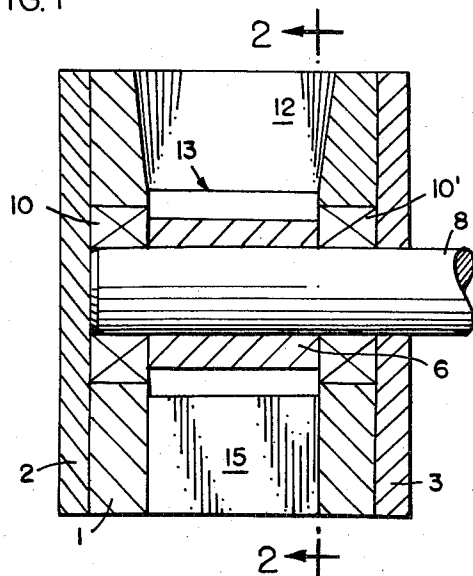
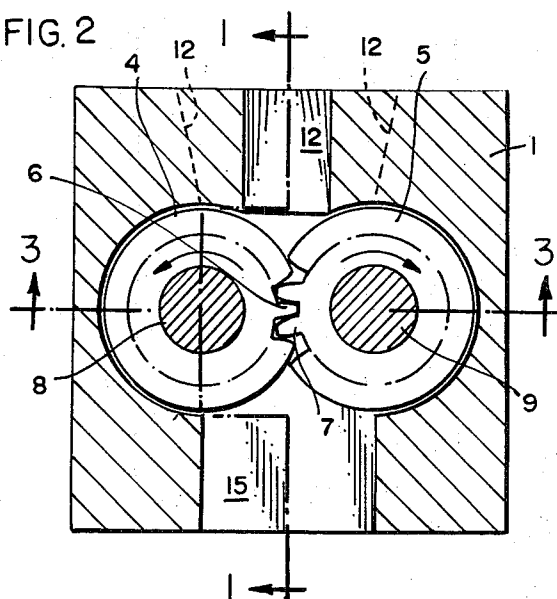


FIG. 2



GEAR WHEEL PUMP WITH FEED PASSAGE OF CONSTANT HYDRAULIC CROSS SECTION

RELATED APPLICATION

This application is a continuation of our U.S. Pat. application Ser. No. 40,279, filed May 25, 1970, now abandoned.

Gear wheel pumps have long been known. They are used for the conveyance of numerous liquid media, for example, oil, spinning solutions, and the like. Depending on the chemical and physical properties of the medium to be conveyed as well as under consideration of the required quantitative performance, the pumps are differently dimensioned in respect to their measurements, the precision of their machining, and their rotary speeds.

In recent time there has existed the desire to use gear wheel pumps of the type described to an increasing degree for the conveying of high-viscosity solutions as well as of molten thermoplastic materials. In particular, there exists a need for large pumps of this type, such as are required, for example, for pumping reaction masses out of reactors or the like, and to feed them, for example, to a granulating device, an extrusion press or to a system of spinning machines. If gear wheel pumps of conventional construction are used for this purpose, the performance capacity of the pump cannot be fully utilized because the viscous reaction mass flows too slowly into the entry or feed passage of the pump. This disadvantage arises especially when the composition has to be conveyed out of vessels maintained at subatmospheric pressures, for example vessels used for degassing of the solutions or melts or for the removal of the monomers.

There exists, accordingly, the problem of providing a gear wheel pump of the type described, which makes it possible to pump efficiently viscous liquids, for example molten thermoplastic polymer compositions, particularly under situations where the compositions are supplied from a vessel or zone under subatmospheric pressure.

THE INVENTION

The invention proceeds to the solution of this problem from the recognition that the entry or feed passage of the gear pumps hitherto known, for example, German Pat. No. 717,630, acts as a choke point with respect to the liquid to be pumped. In order to exclude this undesired influence, the invention provides an entry or feed passage having along its entire length a hydraulic cross section equal to the hydraulic cross section of the rectangular entry opening of the gear-containing pumping chamber.

Hydraulic cross section is defined by the expression:

$$16 F^3/U^2$$

(1)

in which F is the flow-through cross section area and U is the wetted perimeter of the passage. The derivation of this expression takes place by way of the equations for the specific pressure gradient, i.e., the pressure gradient with respect to the tube length unit, in the flowed-through tubes. With differing cross sections the specific pressure gradient (drop) is equal when the hydraulic cross sections are equal.

For the circle there is yielded with

$$F = \pi d^2/4$$

respectively

$$U = \pi \cdot d$$

(d = diameter of circle)

the hydraulic cross section:

$$\pi d^4/4$$

(2)

and for the rectangular tube cross section there is yielded with

$$F = a \times b$$

respectively

$$U = 2(a + b)$$

(a, b = lengths of the sides of the rectangle)

the hydraulic cross section:

$$4 a^3 \times b^3/(a + b)^2$$

(3)

Hydraulic cross section is expressed in dimension units to the fourth power, e.g., cm.⁴ or in.⁴. Speaking in dimension units, hydraulic cross section with units to the fourth power is comparable to dimension units of geometric cross section (in dimension units to the second power, e.g., cm.² or in.²) as the square of the latter. Conversely, geometric cross section, speaking in terms of dimension units, is the square root of hydraulic cross section. For any other tube cross section the hydraulic cross section can be determined from formula (1) by substituting the calculated or otherwise determined values for the flowed-through cross section area and the wetted perimeter.

The cylindrical shape of the gear wheel results in an entry opening at the pumping chamber having a rectangular cross section. Since the connecting lines for pumps virtually always have a round or circular cross section, it is necessary to merge the two cross sections aforementioned one into the other. This is accomplished in known pumps (German Pat. No. 717,630) and also in the pumps herein in the entry or feed passage. In this invention, however, the entry or feed passage has at its end facing the gear wheel pair a rectangular cross section corresponding to the entry opening of the passage with the intermediate portions thereof being transformed, with hydraulic flow cross section remaining constant, gradually toward the entrant end, into its round or circular cross section. In between, the passage has corresponding transitional forms which make possible a steady flow.

The concepts of the invention can be realized in various ways. Thus it is possible, for example, for the entry or feed passage situated in the pump casing to be arranged perpendicularly to the axis of rotation of the gear wheels. This form presents the least flow impediments and is suited, therefore, especially for viscous liquids and melts.

It is also possible, however, for the entrant portion of the feed passage in the pump casing to be substantially parallel to the axis of rotation of the gear wheels. In this case, the pump feed passage opens in a side face of the pump housing.

The invention is explained in further detail with the aid of preferred embodiments illustrated in the drawing, wherein:

FIG. 1 is a longitudinal section along the section plane 1—1 of FIG. 2 of a first embodiment of the invention;

FIG. 2 is a cross section along the section plane 2—2 of FIG. 1;

FIG. 3 is a cross section along the section plane 3—3 of FIG. 2; and

FIG. 4 is a section through a second embodiment of the pump of the invention with entrant portion of the feed passage being parallel to the axis of rotation of the gear wheels.

THE ILLUSTRATED EMBODIMENTS

The pump casing in the embodiments illustrated in the drawing consists substantially of the middle plate 1 as well as the two cover or face plates 2 and 3.

In the middle plate 1 there are situated the two adjacent, side-by-side, cylindrical bores 4 and 5 (see FIG. 2), which are arranged in such a way that their circumferences partially intersect. These bores receive the two gear wheels 6 and 7, which fit precisely into the bores and whose teeth intermesh. The two gear wheels 6 and 7 have the shafts 8 and 9 which serve for the support of the gear wheels and of which one, (in the embodiment illustrated the shaft 8) projects externally and serves as the drive shaft.

The middle plate 1 has a considerably greater thickness than corresponds to the length of the gear wheels 6; 7. The free space on the face sides of the gear wheels in the middle plate 1 serves for the reception of the bearings 10, 10' and 11, 11'. In consequence of this construction, which is in itself known (German Pat. No. 717,630) the cover or face plates 2 and 3 are freed of any load-bearing function and can be constructed correspondingly thin. The thickness of the middle plate 1, however, makes it possible according to the invention to construct the entry passage 12 in such a way that in all places of its length it has a hydraulic cross section equal in size to the hydraulic cross section of the rectangular opening 13 of the gear-containing pumping chamber 14. Thereby, the entry passage 12 does not bring about any choking of the flow of the viscous conveyance material, so that performance capacity of the pump can be utilized efficiently. In the embodiments illustrated, the cross section area of the entry opening 13 is equal to the product of the spacing of the gear axes of rotation and the tooth length. It is also possible, however, to increase this area further, for example, by arrangement of entry pockets which at the gear wheel circumference reach out beyond the axial spacing. The outlet passage 15 for the material pumped extends opposite passage 12 from the pumping chamber 14.

In FIG. 4, another embodiment of the invention is illustrated. The thickness of the middle plate 1 is utilized

to provide in all places along the length of the feed passage 12a a hydraulic cross section equal in size to the hydraulic cross section of the entry opening 13 into the pumping chamber 14. The passage 12a does not run on its entire length perpendicularly to the axis of rotation of the gear wheels, but rather has a 90° radial bend with its entrant portion 16 parallel to said axis. Otherwise, like parts are designated with like reference numbers to those used for the embodiment of FIGS. 1—3. This form of feed passage provides a feed passage through a face plate. Pumps of this type can be mounted, for example, by appropriate flanged connections, directly on vessels or other apparatus.

It is thought that the invention and its numerous attendant advantages will be fully understood from the foregoing description, and it is obvious that numerous changes may be made in the form, construction and arrangement of the several parts without departing from the spirit or scope of the invention, or sacrificing any of its attendant advantages, the forms herein disclosed being preferred embodiments for the purpose of illustrating the invention.

The invention is hereby claimed as follows:

1. In a gear wheel pump adapted for the pumping of viscous melts from a vessel maintained at subatmospheric pressure, a pump casing comprising three plates stacked together in face-to-face relationship, the middle plate thereof having two, partially intersecting, transverse bores next to one another, said bores together providing a pumping chamber with a rectangular entrant opening, a pair of intermeshing toothed gear wheels rotatably mounted in the respective bores, shaft means for driving rotatably one of said gear wheels, said rectangular entrant opening having a cross section at least equal in cross section area to the product of the distance between the axes of rotation of said gear wheels times the tooth length of said gear wheels, said middle plate further having therein a feed passage and a discharge passage respectively intersecting opposite sides of said pumping chamber, and said feed passage having at its end adjacent said entrant opening of said pumping chamber a rectangular cross section corresponding to the rectangular entrant opening and further, with its hydraulic cross section remaining constant, being transformed gradually toward a circular entrant opening in said middle plate, said hydraulic cross section being expressed as $16F^3/U^2$ wherein F denotes the flow-through cross section throughout the feed passage area and U is the wetted perimeter of the corresponding part of said passage.

2. A gear wheel pump as claimed in claim 1, wherein said feed passage extends perpendicularly to the axes of rotation of said gear wheels.

3. A gear wheel pump as claimed in claim 1, wherein said feed passage has a 90° bend with the circular entrant portion being parallel to the axes of rotation of said gear wheels.

* * * * *

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,817,668 Dated June 18, 1974

Inventor(s) Karl Mayer et al.

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

In the Heading, insert -- [30] Foreign Application

Priority Data May 28, 1969 Germany 69 21 358 --.

In the Heading, insert -- [73] Assignee: Barmag Barmer
Maschinenfabrik Aktiengesellschaft, Wuppertal, Germany --.

Signed and Sealed this

Twenty-eighth **Day of** June 1977

[SEAL]

Attest:

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